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Cruise report
R/V “Oceania”, Arex 2005

Ship	R/V “Oceania”
Cruise	Arex2005
Dates	8.06.2005 – 18.07.2005
Port Calls	Gdansk (Poland) – Longyearbyen (Spitsbergen)
Number of Scientist	11
Chief Scientist	dr Waldemar Walczowski
Principal Project	ASOF-N, WP1
Research Area	Greenland Sea

WP1. Atlantic Water pathways in the Greenland Sea

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1. Introduction

Institute of Oceanology Polish Academy of Sciences has been doing oceanographic research in the Norwegian, Greenland and Barents Seas since 1987. During summer cruises hydrographic data are collected, some at the same permanent stations and transects. Since 1993 the VM ADCP data has been installed, since 2003 the lowered ADCP measurements have been introduced.

Measurements were conducted within the Atlantic Domain of the Norwegian and Greenland Sea, between Barents Sea slope and underwater ridges system – Mohns Ridge and Knipovich Ridge. Due to convergence of the isobaths in the northern part, AW domain forms wedge, wide in southern part and narrow in the northern end. Specific bottom topography meaningfully influences the currents pattern and structure. Coverage in the southern part of investigated area is spare in comparison to the northern one. This causes less accurate horizontal distribution of properties in the region south of the Bear Island. Our main effort was concentrated in the northern part of Atlantic Domain where processes controlling the AW inflow into Arctic Ocean through the Fram Strait and the westward recirculation take place.

2. Observations in 2005

AREX2005 cruise of the R/V Oceania was performed in the period of June 08 2005 – August 18 2005. 200 CTD (conductivity, temperature, depth) profiles along 13 sections were done (Fig. 1, Tab.1). Sections were situated perpendicular to the supposed direction of the Atlantic Water flow. Some profiles were done near ice pack to observe the water conditions and intrusions.

For CTD measurements the Seabird SBE9/11plus probe was used. The probe was serviced before the cruise. Temperature and conductivity sensors were calibrated by the Sea-Bird Electronics service. Water samples collected by means of the rosette water sampler SBE32 were analysed at the ship and in IOPAS laboratory with the Guildline Autosol 8400A. Water temperature was checked by electronic reversing thermometers.

Measurements of currents were performed by means of lowered Acoustic Doppler Current Profiler (LADCP). The self-recording 300 kHz RDI device was used to profile entire water column during the standard CTD casts.

During the whole cruise continuous currents measurements by the shipmounted ADCP, RDI 150 kHz were conducted.

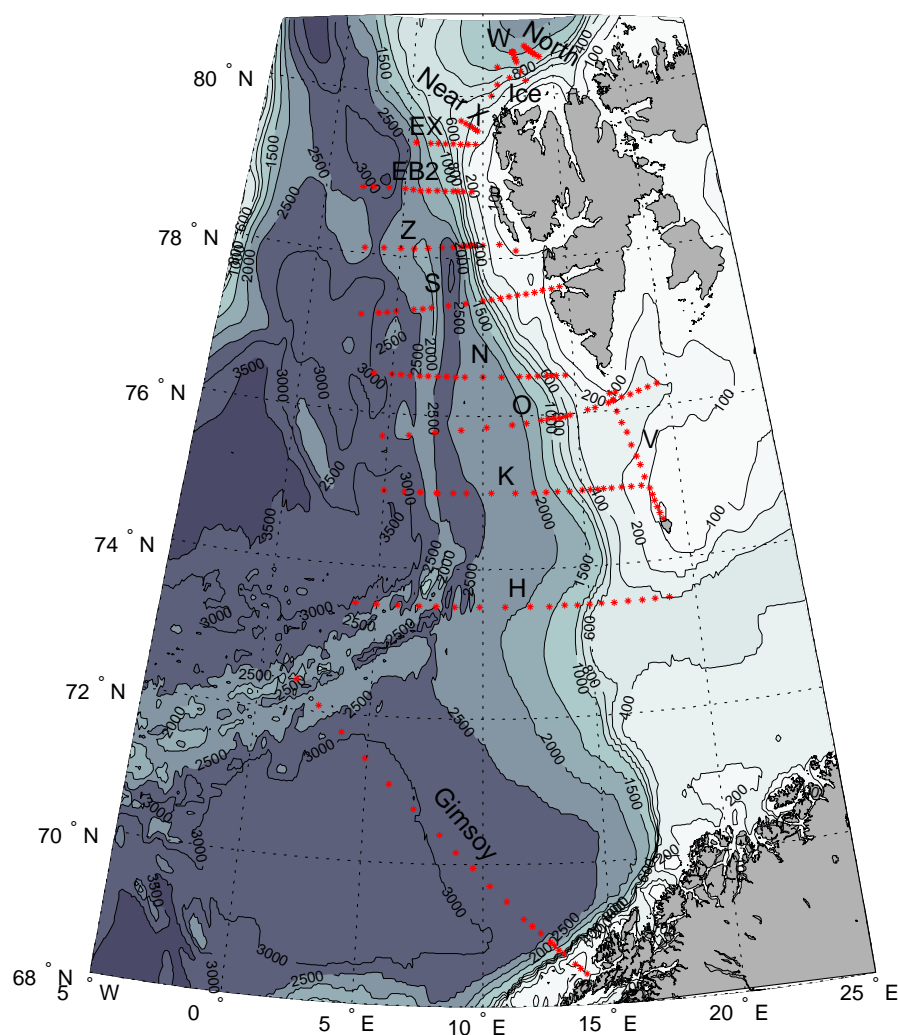


Fig. 1. Grid of CTD stations performed in summer 2005. Most of all sections are parallel or near parallel. They cut across West Spitsbergen Current. Sections Gimsøy, NearX, W and North close WSC region from south and north. Meridional section V and east part of section O provide data from Storfjordrenna and Byørnøyarennå..

Table 1

CTD stations and some of their main parameters. There are 10 regular sections and some short sections: W, North, Near X. Additionally, there are several stations near ice cover north of Spitsbergen.

Cast	Station	File	Latitude	Longitude	Date, Time	Depth	Comments
Gimsøy							
1	G02	AR05_001	68.434	14.026	20-Jun-2005 06:53:27	103	
2	G04	AR05_002	68.514	13.781	20-Jun-2005 08:17:09	138	
3	G06	AR05_003	68.581	13.578	20-Jun-2005 09:27:24	135	
4	G08	AR05_004	68.735	13.169	20-Jun-2005 11:24:41	113	
5	G09	AR05_005	68.785	12.973	20-Jun-2005 12:58:37	184	
6	G10	AR05_006	68.853	12.806	20-Jun-2005 14:09:13	694	
7	G11	AR05_007	68.902	12.638	20-Jun-2005 15:48:32	1243	
8	G12	AR05_008	69.033	12.284	20-Jun-2005 18:44:54	2787	
9	G13	AR05_009	69.133	11.947	20-Jun-2005 22:29:54	2952	
10	G14	AR05_010	69.233	11.625	21-Jun-2005 03:09:07	2977	

11	G15	AR05_011	69.485	10.960	21-Jun-2005 09:18:41	2997	
12	G16	AR05_012	69.701	10.273	21-Jun-2005 15:19:39	2975	
13	G17	AR05_013	69.950	9.586	21-Jun-2005 21:19:57	2924	
14	G18	AR05_014	70.166	8.883	22-Jun-2005 03:33:30	2941	
15	G19	AR05_015	70.401	8.197	22-Jun-2005 08:38:42	2965	
16	G20	AR05_016	70.751	7.087	22-Jun-2005 15:05:28	3064	
17	G21	AR05_017	71.085	5.997	22-Jun-2005 21:28:21	3132	
18	G22	AR05_018	71.417	4.913	23-Jun-2005 03:20:34	2822	
19	G23	AR05_019	71.750	3.833	23-Jun-2005 09:23:11	3093	
20	G24	AR05_020	72.082	2.747	23-Jun-2005 16:41:30	2365	
21	G25	AR05_021	72.416	1.668	23-Jun-2005 23:16:38	3097	
Section H							
22	H19	AR05_022	73.500	4.000	24-Jun-2005 13:34:23	2883	
23	H18	AR05_023	73.499	5.002	24-Jun-2005 17:49:25	2765	
24	H17	AR05_024	73.499	5.991	24-Jun-2005 21:50:28	2079	
25	H16	AR05_025	73.503	7.008	25-Jun-2005 01:50:50	2371	
26	H15	AR05_026	73.500	7.801	25-Jun-2005 05:18:27	3117	
27	H14	AR05_027	73.498	8.667	25-Jun-2005 09:19:58	2518	
28	H13	AR05_028	73.499	9.835	25-Jun-2005 14:12:39	2324	
29	H12	AR05_029	73.499	11.039	25-Jun-2005 18:24:38	2086	
30	H11	AR05_030	73.500	12.204	25-Jun-2005 22:33:24	1826	
31	H10	AR05_031	73.494	13.103	26-Jun-2005 02:55:42	1586	
32	H9	AR05_032	73.502	13.834	26-Jun-2005 05:56:56	1308	
33	H8	AR05_033	73.497	14.426	26-Jun-2005 08:21:59	1011	
34	H4	AR05_034	73.497	15.000	26-Jun-2005 11:21:02	682	
35	H7	AR05_035	73.499	15.560	26-Jun-2005 13:36:03	482	
36	H6	AR05_036	73.498	16.170	26-Jun-2005 15:40:16	461	
37	H5	AR05_037	73.499	16.816	26-Jun-2005 17:38:49	449	
38	H3	AR05_038	73.499	17.479	26-Jun-2005 19:43:28	427	
39	H2	AR05_039	73.499	18.093	26-Jun-2005 21:45:35	412	
40	H1	AR05_040	73.499	18.749	26-Jun-2005 23:55:06	431	
Section V							
41	V21	AR05_041	74.533	18.894	27-Jun-2005 18:36:45	22	
42	V22	AR05_042	74.616	18.759	27-Jun-2005 19:52:01	66	
43	V23	AR05_043	74.699	18.661	27-Jun-2005 21:09:13	96	
44	V24	AR05_044	74.782	18.565	27-Jun-2005 22:28:35	221	
45	V25	AR05_045	74.864	18.496	27-Jun-2005 23:53:53	200	
46	V26	AR05_046	74.949	18.406	28-Jun-2005 01:17:06	70	
47	V27	AR05_047	75.101	18.211	28-Jun-2005 03:01:56	70	
48	V28	AR05_048	75.267	18.049	28-Jun-2005 04:42:35	61	
49	V29	AR05_049	75.384	17.914	28-Jun-2005 05:57:34	103	
50	V30	AR05_050	75.535	17.716	28-Jun-2005 07:35:25	131	
51	V31	AR05_051	75.700	17.551	28-Jun-2005 09:22:53	211	
52	V32	AR05_052	75.832	17.333	28-Jun-2005 11:01:58	290	
53	V33	AR05_053	75.982	17.127	28-Jun-2005 12:55:41	321	
54	V34	AR05_054	76.125	16.993	28-Jun-2005 14:59:40	295	
55	V35a	AR05_055	76.223	16.840	28-Jun-2005 16:29:40	234	ice
56	V35b	AR05_056	76.226	17.140	28-Jun-2005 17:40:03	269	ice

Section O							
57	O4	AR05_057	76.133	17.001	28-Jun-2005 18:57:30	283	
58	O5	AR05_058	76.158	17.466	28-Jun-2005 20:51:20	310	
59	O6	AR05_059	76.183	17.922	28-Jun-2005 22:08:30	276	
60	O7	AR05_060	76.217	18.417	29-Jun-2005 00:07:33	250	
61	O8	AR05_061	76.250	18.917	29-Jun-2005 01:43:48	262	
62	O9	AR05_062	76.283	19.420	29-Jun-2005 03:10:59	253	
63	O3A	AR05_063	76.105	16.722	29-Jun-2005 10:41:29	321	ice
64	O2A	AR05_064	76.056	16.002	29-Jun-2005 13:06:46	390	ice
65	O1A	AR05_065	76.037	15.591	29-Jun-2005 14:22:29	369	ice
Section K							
66	K-3	AR05_066	74.999	18.004	30-Jun-2005 00:30:34	153	
67	K-2	AR05_067	75.000	17.499	30-Jun-2005 02:18:19	114	
68	K-1	AR05_068	75.000	16.995	30-Jun-2005 03:43:59	127	
69	K0	AR05_069	75.000	16.502	30-Jun-2005 05:07:01	224	
70	K1	AR05_070	75.000	16.086	30-Jun-2005 06:24:39	215	
71	K2	AR05_071	75.000	15.785	30-Jun-2005 07:25:53	338	up
72	K3	AR05_072	75.000	15.427	30-Jun-2005 08:40:15	808	
73	K4	AR05_073	75.000	15.005	30-Jun-2005 10:38:44	1117	
74	K5	AR05_074	75.000	14.369	30-Jun-2005 13:11:29	1525	
75	K6	AR05_075	75.000	13.752	30-Jun-2005 15:42:54	1816	
76	K7	AR05_076	74.999	13.187	30-Jun-2005 18:29:52	2004	
77	K8	AR05_077	75.000	12.556	30-Jun-2005 21:33:14	2166	
78	K9	AR05_078	75.000	11.634	01-Jul-2005 01:07:15	2390	
79	K10	AR05_079	75.000	10.415	01-Jul-2005 05:38:13	2537	
80	K11	AR05_080	75.001	9.170	01-Jul-2005 09:57:08	2638	
81	K12	AR05_081	75.001	8.501	01-Jul-2005 13:18:47	2917	
82	K13	AR05_082	75.000	7.666	01-Jul-2005 17:56:39	2262	
83	K13	AR05_083	74.991	7.725	01-Jul-2005 19:52:21	1013	additional
84	K14	AR05_084	75.000	6.835	01-Jul-2005 23:35:28	2065	
85	K15	AR05_085	74.999	6.009	02-Jul-2005 03:03:09	2883	
86	K16	AR05_086	75.002	5.000	02-Jul-2005 07:43:20	3133	
Section O continuation							
87	O-13	AR05_087	75.700	4.717	02-Jul-2005 15:45:10	2842	
88	O-12	AR05_088	75.734	6.101	02-Jul-2005 20:17:11	2558	
89	O-11	AR05_089	75.784	7.470	03-Jul-2005 00:41:57	2550	
90	O-10	AR05_090	75.816	8.837	03-Jul-2005 04:57:55	2391	
91	O-9	AR05_091	75.850	10.202	03-Jul-2005 08:55:21	2327	
92	O-8	AR05_092	75.883	11.551	03-Jul-2005 12:51:01	2092	
93	O-7	AR05_093	75.899	12.302	03-Jul-2005 15:29:57	1802	
94	O-6	AR05_094	75.934	13.088	03-Jul-2005 18:16:26	1386	
95	O-5	AR05_095	75.950	13.437	03-Jul-2005 19:56:20	1162	
96	O-4	AR05_096	75.950	13.786	03-Jul-2005 21:21:14	906	
97	O-3	AR05_097	75.950	14.088	03-Jul-2005 22:32:00	606	
98	O-2	AR05_098	75.967	14.375	03-Jul-2005 23:33:41	331	
99	O-1	AR05_099	75.982	14.624	04-Jul-2005 00:20:45	321	
Section N							
100	N3P	AR05_100	76.500	14.503	04-Jul-2005 06:00:12	213	
101	N3	AR05_101	76.500	14.002	04-Jul-2005 07:43:26	757	
102	N2pp	AR05_102	76.499	13.747	04-Jul-2005 08:57:20	1087	additional
103	N2p	AR05_103	76.501	13.496	04-Jul-2005 10:14:10	1273	

104	N2	AR05_104	76.502	12.994	04-Jul-2005 12:01:23	1554	
105	N1p	AR05_105	76.500	12.498	04-Jul-2005 13:56:12	1757	
106	N1	AR05_106	76.500	12.000	04-Jul-2005 15:56:17	1912	
107	N0	AR05_107	76.499	11.005	04-Jul-2005 19:12:27	2114	
108	N-1	AR05_108	76.501	9.998	04-Jul-2005 22:47:09	2256	
109	N-2	AR05_109	76.500	9.003	05-Jul-2005 02:25:12	2291	
110	N-3	AR05_110	76.499	8.500	05-Jul-2005 04:55:29	2294	
111	N-4	AR05_111	76.500	8.007	05-Jul-2005 07:22:47	1866	
112	N-5	AR05_112	76.502	7.500	05-Jul-2005 09:40:48	2516	
113	N-6	AR05_113	76.501	7.002	05-Jul-2005 12:28:27	2955	
114	N-7	AR05_114	76.500	6.508	05-Jul-2005 16:33:34	2517	
115	N-8	AR05_115	76.500	6.002	05-Jul-2005 19:46:44	2567	
116	N-9	AR05_116	76.501	5.501	05-Jul-2005 22:37:55	2582	
117	N-10	AR05_117	76.501	5.001	06-Jul-2005 01:30:19	2409	
118	N-11	AR05_118	76.500	4.005	06-Jul-2005 05:17:22	2510	
Section S							
119	S16	AR05_119	77.235	2.997	06-Jul-2005 12:33:54	2928	
120	S15	AR05_120	77.268	4.001	06-Jul-2005 17:49:06	2589	
121	S14	AR05_121	77.285	4.496	06-Jul-2005 20:42:45	2311	
122	S13	AR05_122	77.301	5.002	06-Jul-2005 23:25:23	2446	
123	S12	AR05_123	77.336	6.008	07-Jul-2005 02:59:23	2613	
124	S11	AR05_124	77.352	6.504	07-Jul-2005 07:03:06	2146	
125	S10	AR05_125	77.370	7.001	07-Jul-2005 09:34:21	2700	
126	S9	AR05_126	77.401	8.002	07-Jul-2005 13:13:16	2320	
127	S8	AR05_127	77.434	9.000	07-Jul-2005 16:31:06	2082	
128	S7	AR05_128	77.468	10.002	07-Jul-2005 19:43:08	1606	
129	S6	AR05_129	77.484	10.501	07-Jul-2005 21:37:46	1255	
130	S5	AR05_130	77.500	11.004	07-Jul-2005 23:16:26	702	
131	S4	AR05_131	77.517	11.500	08-Jul-2005 00:37:55	277	
132	S3	AR05_132	77.535	12.002	08-Jul-2005 01:50:09	171	
133	S2	AR05_133	77.551	12.499	08-Jul-2005 03:02:24	98	
134	S1	AR05_134	77.567	13.005	08-Jul-2005 04:10:16	133	
135	S0	AR05_135	77.583	13.500	08-Jul-2005 05:18:01	144	
136	S-1	AR05_136	77.601	14.006	08-Jul-2005 06:25:45	139	
137	S-2	AR05_137	77.618	14.502	08-Jul-2005 07:35:49	133	
Section EB2							
138	EB2-1	AR05_138	78.831	9.278	12-Jul-2005 11:36:27	199	
139	EB2-2	AR05_139	78.833	8.734	12-Jul-2005 13:06:05	214	
140	EB2-3	AR05_140	78.835	8.399	12-Jul-2005 13:57:08	710	
141	EB2-4	AR05_141	78.833	8.083	12-Jul-2005 15:05:56	975	
142	EB2-5	AR05_142	78.835	7.561	12-Jul-2005 16:50:39	1129	
143	EB2-6	AR05_143	78.833	7.073	12-Jul-2005 18:38:17	1388	
144	EB2-7	AR05_144	78.832	6.508	12-Jul-2005 20:59:00	1953	
145	EB2-8	AR05_145	78.827	6.027	12-Jul-2005 23:37:14	2436	
146	EB2-9	AR05_146	78.833	5.530	13-Jul-2005 02:15:38	2588	
147	EB2-10	AR05_147	78.835	5.010	13-Jul-2005 05:10:09	2686	
148	EB2-11	AR05_148	78.834	4.000	13-Jul-2005 09:26:11	2326	
149	EB2-12	AR05_149	78.832	2.998	13-Jul-2005 12:47:43	2453	
150	EB2-13a	AR05_150	78.821	2.346	13-Jul-2005 15:51:12	2528	ice

Section EX							
151	EX8	AR05_151	79.414	5.537	14-Jul-2005 02:07:31	2161	
152	EX7	AR05_152	79.417	6.509	14-Jul-2005 07:46:13	1444	
153	EX6	AR05_153	79.416	7.009	14-Jul-2005 09:24:49	1195	
154	EX5	AR05_154	79.416	7.512	14-Jul-2005 10:54:32	892	
155	EX4	AR05_155	79.416	8.010	14-Jul-2005 12:16:20	404	
156	EX3	AR05_156	79.415	8.502	14-Jul-2005 13:25:09	188	
157	EX2	AR05_157	79.416	8.999	14-Jul-2005 14:27:16	128	
158	EX1	AR05_158	79.417	9.503	14-Jul-2005 15:26:58	124	
Section W							
159	W1	AR05_159	80.183	13.011	14-Jul-2005 22:52:33	138	
160	W2	AR05_160	80.299	12.711	15-Jul-2005 00:29:51	187	
161	W3	AR05_161	80.417	12.422	15-Jul-2005 02:04:02	204	
162	W4	AR05_162	80.532	12.134	15-Jul-2005 03:33:01	883	
163	W3a	AR05_163	80.474	12.277	15-Jul-2005 05:13:38	602	ice
164	W3b	AR05_164	80.445	12.363	15-Jul-2005 06:00:41	421	ice
165	W5	AR05_165	80.534	12.108	15-Jul-2005 07:33:06	896	ice
166	W5	AR05_166	80.535	12.146	15-Jul-2005 08:19:49	895	ice
167	W5	AR05_167	80.531	12.185	15-Jul-2005 09:09:40	502	ice
168	W5	AR05_168	80.530	12.209	15-Jul-2005 09:38:19	501	ice
North							
169	169	AR05_169	80.601	13.008	15-Jul-2005 11:59:33	857	
170	170	AR05_170	80.574	13.197	15-Jul-2005 12:55:18	661	
171	171	AR05_171	80.552	13.339	15-Jul-2005 13:40:12	482	
172	172	AR05_172	80.536	13.467	15-Jul-2005 14:19:07	292	
173	173	AR05_173	80.517	13.622	15-Jul-2005 15:01:25	192	
174	174	AR05_174	80.497	13.813	15-Jul-2005 15:40:18	139	
175	175	AR05_175	80.467	14.065	15-Jul-2005 16:24:30	115	
Ice							
176	176	AR05_176	80.358	11.010	15-Jul-2005 22:38:57	480	
177	177	AR05_177	80.225	11.897	16-Jul-2005 01:37:14	165	
178	178	AR05_178	80.144	10.993	16-Jul-2005 04:15:24	290	
179	179	AR05_179	80.011	10.578	16-Jul-2005 07:10:06	422	
Near X							
180	180	AR05_180	79.580	9.640	16-Jul-2005 11:52:14	124	
181	181	AR05_181	79.598	9.499	16-Jul-2005 12:28:16	198	
182	182	AR05_182	79.625	9.250	16-Jul-2005 13:17:28	337	
183	183	AR05_183	79.645	9.088	16-Jul-2005 14:03:10	391	
184	184	AR05_184	79.669	8.823	16-Jul-2005 15:05:39	440	
185	185	AR05_185	79.702	8.511	16-Jul-2005 16:21:56	511	
Section Z							
186	Z13	AR05_186	78.067	2.833	17-Jul 11:56:36	3051	
187	Z12	AR05_187	78.084	4.001	17-Jul 16:00:13	2884	
188	Z11	AR05_188	78.093	5.024	17-Jul 20:16:43	2679	
189	Z10	AR05_189	78.100	5.840	17-Jul 23:19:12	2515	
190	Z9	AR05_190	78.116	6.671	18-Jul 02:21:11	2357	
191	Z8	AR05_191	78.131	7.502	18-Jul 05:24:14	3402	deeper
192	Z7	AR05_192	78.142	8.175	18-Jul 09:02:37	2156	
193	Z6	AR05_193	78.147	8.675	18-Jul 11:27:08	1548	
194	Z5	AR05_194	78.158	9.007	18-Jul 13:10:14	1088	

195	Z4	AR05_195	78.161	9.256	18-Jul 14:32:13	671	
196	Z4a	AR05_196	78.169	9.321	18-Jul 16:11:40	530	additional
197	Z3	AR05_197	78.163	9.501	18-Jul 17:38:21	266	
198	Z2	AR05_198	78.167	10.003	18-Jul 18:47:28	263	
199	Z1	AR05_199	78.176	11.003	18-Jul 20:49:41	260	
200							
200	200	AR05_200	78.092	12.000	18-Jul 23:08:25	238	

3. Some preliminary results

Figure 2 presents potential temperature and salinity diagrams for particular sections which were situated across West Spitsbergen Current. Each section includes different types of profiles. Some of them represent shallow region of continental shelf westward of Svalbard. The others show situation on shelf break, continental slope or near ridges. Those different bottom conditions and geographical location determine properties of water masses: potential temperature, salinity and potential density.

The general flow structure cross the sections, obtained from baroclinic calculations, ADCP and LADCP measurements was similar (Fig.3) however baroclinic transports calculated from hydrological data and total transports from LADCP measurements differ a lot.

As in earlier cruises, during 2005 cruise two northward flowing branches of Atlantic Water in the Greenland Sea were observed. The main branch of the West Spitsbergen Current flows along the Barents Sea continental slope and Spitsbergen shelf break. The second, colder and less saline branch continues along the Mohns and Knipovich Ridges as a jet stream of the Arctic Front. Due to the bottom topography, both branches of AW converge west of the southern Spitsbergen coast.

Figure 4 presents the distribution of temperature and baroclinic currents at depth 100 m (calculated for the reference level of 1000 m.) during summer 2005. To reduce effect of non-uniform data spacing, temperature and HD fields were smoothed and filtered. Finally, the picture of general currents pattern was obtained, rather than synoptic snapshot. Like in 2004, westward recirculation of AW was in 2005 limited. Northward transport of AW by branch related to the Spitsbergen slope was relatively high. Two large anticyclonic eddies carried high amount of heat were observed the Arctic Front.

In conclusion the AW temperature in 2005 was very high, even higher than in 2004 (fig 5). Also calculated heat content in the AW layer was higher than in 2004. It concerns the whole domain, also southern part. These data show that during 2006 continuation of high heat inflow into the AO will take place.

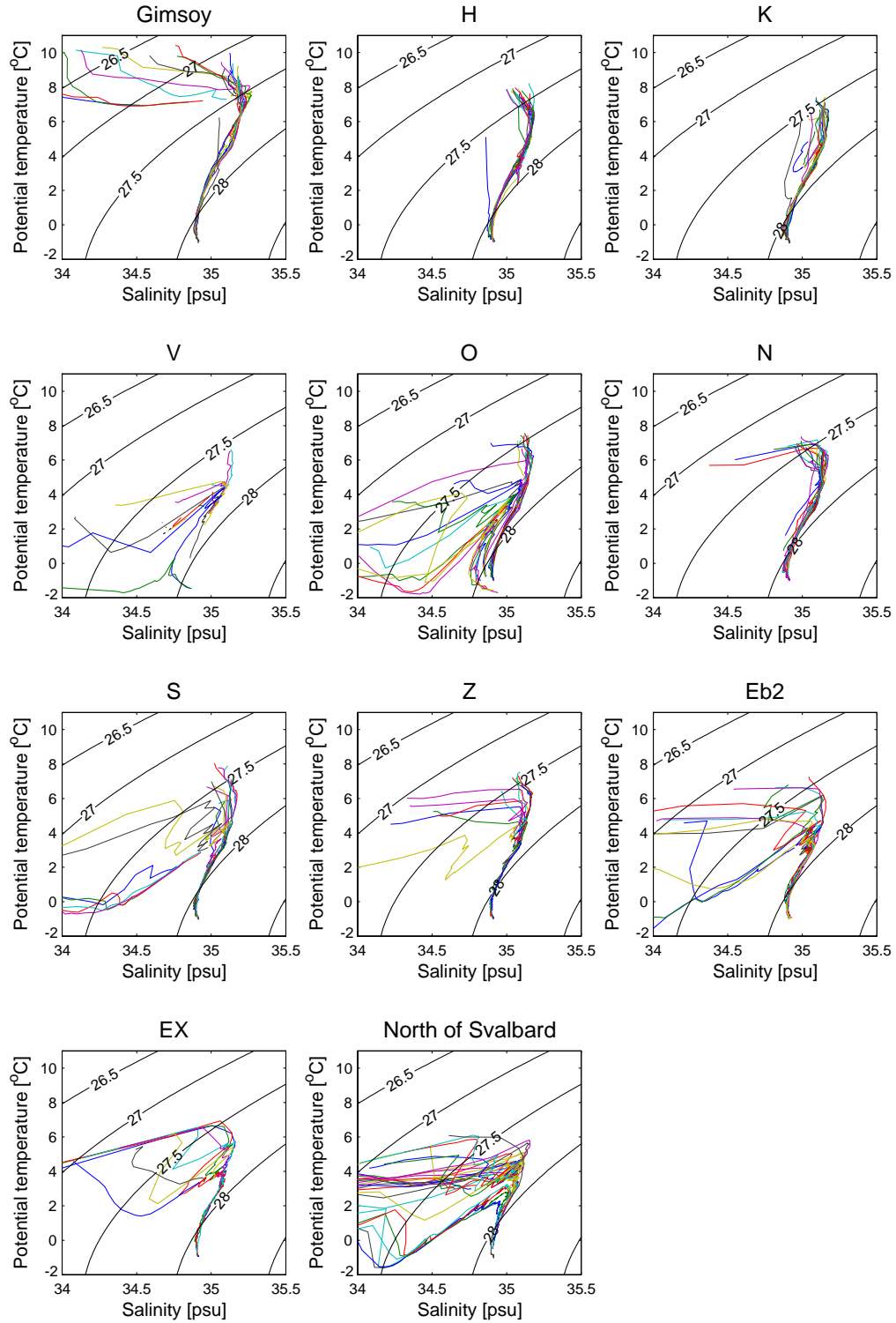


Fig. 2. Potential temperature and salinity diagrams with contours of corresponding σ_θ for all hydrographical profiles performed on 2005 cruise. Particular plots present data from different sections. Profiles from north of Svalbard are collected on one graph.

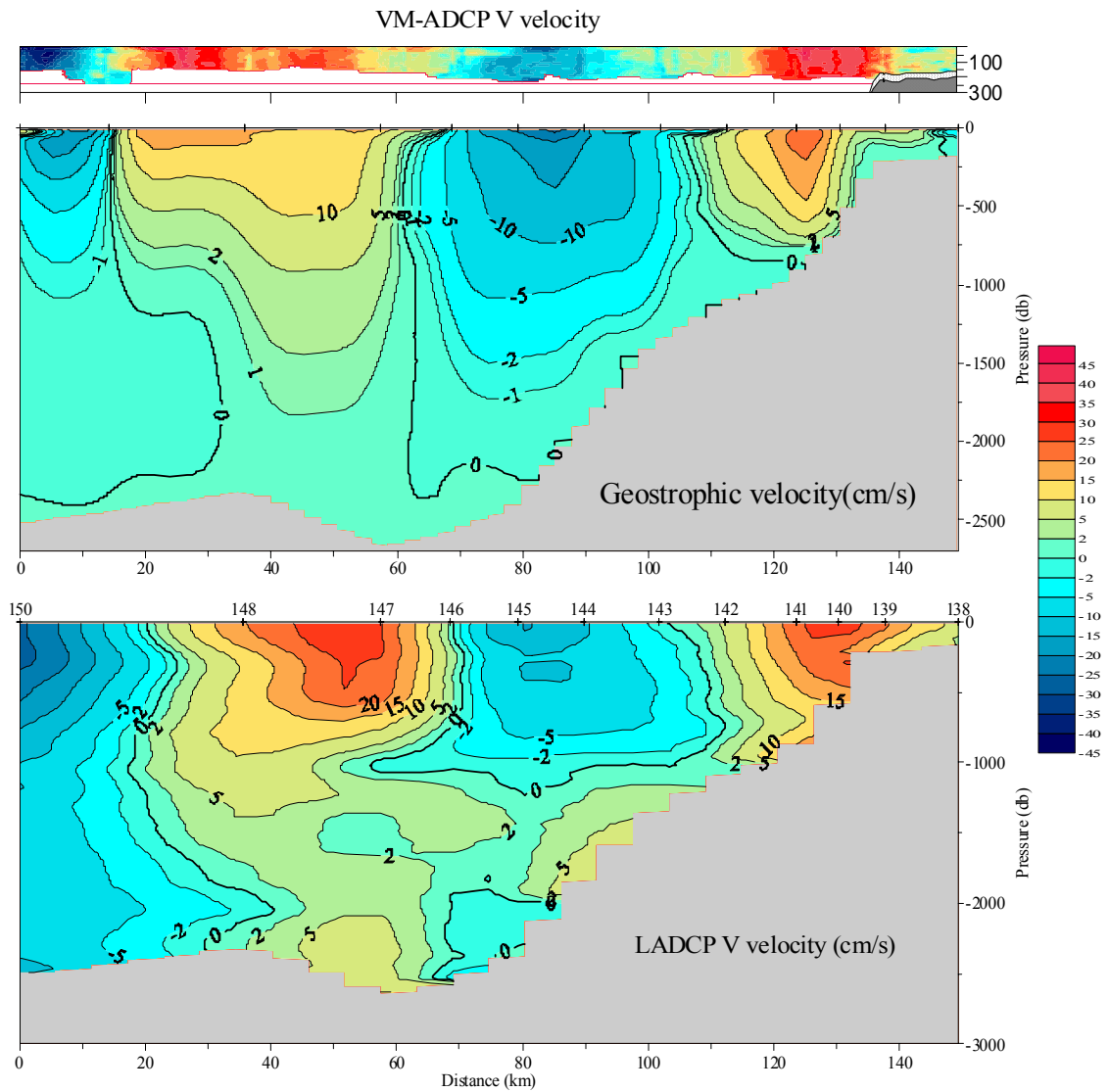


Fig. 3. VM-ADCP currents (upper bar), geostrophic baroclinic currents and LADCP measured flows cross the West Spitsbergen Current. Section EB2 along the 78° 50'N. R.V. 'Oceania', June 2005.

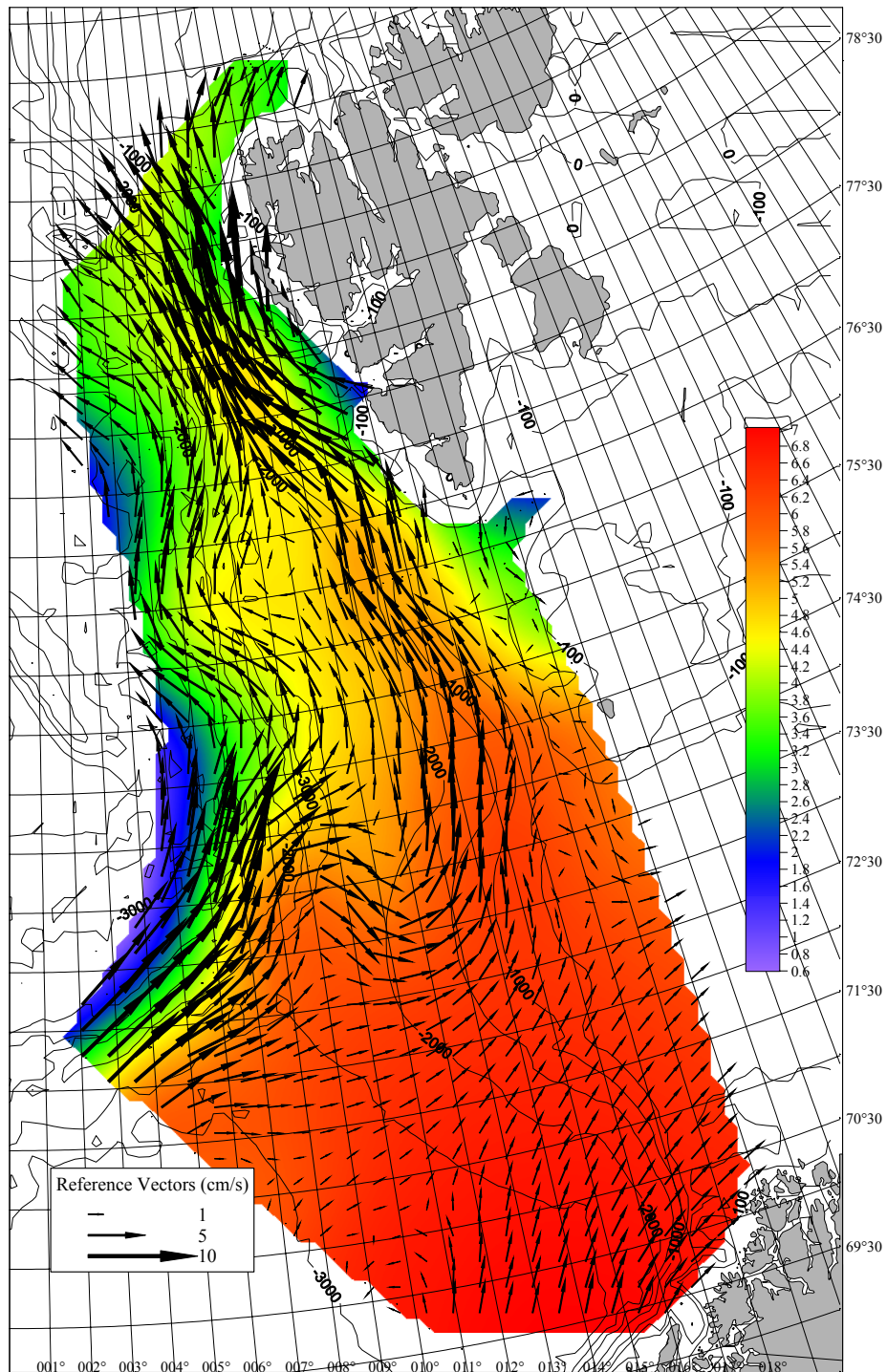


Fig. 4 June-July 2005. Smoothed temperature distribution and baroclinic currents at 100 m. Reference level 1000 m.

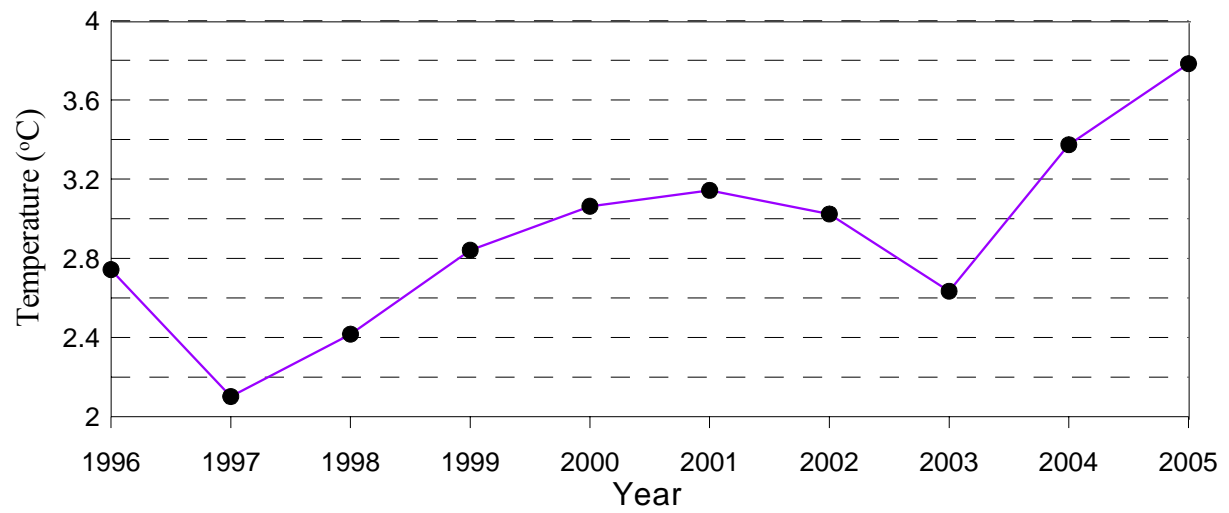


Fig. 5. Changing of mean temperature at 200 m of section 'N' (76° 30' N) between latitudes 09-12° E.